

NATIONAL BUREAU OF STANDARDS REPORT

4150

PERFORMANCE TEST OF TWO 1-INCH GLASFLOSS
THROWAWAY-TYPE AIR FILTERS
(IN TANDEM)

by

Henry E. Robinson
Thomas W. Watson

Report to

General Services Administration
Public Buildings Service
Washington 25, D. C.



**U. S. DEPARTMENT OF COMMERCE
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NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT

NBS REPORT

1000-30-4830

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4150

PERFORMANCE TESTS OF TWO 1-INCH GLASFLOSS THROWAWAY-TYPE AIR FILTERS (IN TANDEM)

Manufactured by
Pittsburgh Plate Glass Company
Pittsburgh, Pennsylvania

by

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Thomas W. Watson

to

General Services Administration
Public Buildings Service
Washington 25, D. C.



U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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PERFORMANCE TESTS OF TWO 1-INCH GLASFLOSS
THROWAWAY-TYPE AIR FILTERS
(In Tandem)

1. INTRODUCTION

At the request of the Public Buildings Service, General Services Administration, the performance characteristics of throwaway-type air filters were determined to provide information to assist in the preparation of new air filter specifications.

The test results presented herein were obtained on two one-inch air filters, of the throwaway-type, in tandem, submitted by the manufacturer at the request of the Public Buildings service and included determinations of dust arresting efficiency with two aerosols (atmospheric air and Cottrell precipitate), pressure drop and dirt load.

2. DESCRIPTION OF THE FILTER SPECIMENS

The filters were manufactured by the Pittsburgh Plate Glass Company, Fiber Glass Division, Pittsburgh, Pennsylvania, and were of the throwaway-type. Two similar specimens were submitted. Each was identified by nameplate as a "Glasfloss Air Filter, Replacement Type", nominal 20x20x1-inch in size, and had media of fine-fibered glass strewn in a loose pack one inch thick covered on the faces by retainers of thin brass sheet from which circular discs had been stamped, leaving a grid of circular openings. The edges of the filter were enclosed in a cardboard frame, leaving a free opening 17 5/8 inches square, (2.16 ft²). The glass fibers were lightly coated with a reddish-brown adhesive. The filters had actual outside dimensions of 19 5/8 x 19 5/8 x 1 inch and each weighed 0.87 lb. when clean. The filter specimens had an Underwriters Laboratories stamp on the cardboard frame.

3. TEST METHOD AND PROCEDURE

Efficiency determinations were made by the NBS "Dust-Spot Method" using the following aerosols: (a) outdoor atmospheric air drawn through the laboratory without addition of other dust or contaminant; and (b) Cottrell precipitate, dispersed in the outdoor

atmospheric air. The test method is described in the paper "A Test Method for Air Filters" by R. S. Dill (ASHVE Transactions, Vol. 44, p 379, 1938).

For these tests, the two filters were installed in the apparatus in tandem forming an assembly two inches thick and the desired rate of air flow through them was established. Samples of air were drawn from the center of the test duct, at points one foot upstream and eight feet downstream of the filters and passed through known areas of Whatman No. 41 filter paper. The areas of the filter paper used upstream and downstream, or the times during which the air was sampled upstream and downstream, were selected experimentally so that the change in transmission of light through the two filter paper spots would be about the same. The filter efficiency was calculated by means of the formula

$$\text{Efficiency, percent} = 100 \left[1 - \frac{A_2}{A_1} \cdot \frac{O_2}{O_1} \cdot \frac{T_1}{T_2} \right]$$

where A represents the dust spot area, O the change in light transmittance of the filter paper as measured before and after the deposition of dust, and T the time during which the air sample was drawn. Subscripts 1 and 2 refer to the upstream and downstream positions, respectively.

Three efficiency-measuring techniques, or modifications based on the above formula, were used, depending on the apparent efficiency of the filter with the different aerosols. For the tests made, techniques L, M and N were used, as indicated and described in Table 2.

All light transmission measurements were made with the photometer illumination at a constant intensity as determined by measurement on a reference of constant transmission characteristics. The filter papers used upstream and downstream were selected to have equal light transmissions when clean.

The efficiency of the filter combination in arresting particulate matter in atmospheric air was determined by means of two tests of the L and M types, as shown in Table 2, with the filter clean. Following these, the efficiency of the filter in arresting Cottrell precipitate was measured by means of two N-type tests, after

which was begun the process of loading the filter with a mixture of four percent of cotton lint and 96 percent of Cottrell precipitate, by weight, separately dispersed in the air stream. The lint used for this purpose was No. 7 cotton linters previously ground in a Wiley mill with a 4-millimeter screen. At suitable periods as the loading progressed, the efficiency of the filter was determined using Cottrell precipitate in outdoor air. Pressure drops were recorded at intervals during the test. The dirt-loading was continued until the pressure drop increased to approximately 0.50 inch W.G. The efficiency was again determined with Cottrell precipitate and then with atmospheric air as the aerosols.

4. TEST RESULTS

Table 1 presents data as to the pressure drop, at several rates of air flow, of the clean filter combination.

The performance of the tandem combination at 800 cfm is summarized in Table 2, for both aerosols A and C. The performance of the filters in regard to aerosol C (Cottrell precipitate in atmospheric air) is also shown graphically in figure 1. The efficiency of the filters in arresting aerosol A (atmospheric particulate matter), both initially, and after the resistance had been increased to 0.5 inch W. G., is indicated in Table 2.

Observation of the filters at the end of the dirt-loading tests revealed that the greater part of the arrested dust and lint had not penetrated the media beyond a depth of about 1/2 inch. The downstream surfaces of the media of the upstream filter of the tandem combination were discolored; the upstream surfaces of the downstream filter were slightly discolored; the downstream surfaces showed little discoloration. Lint deposits were visible in the upstream 1/2 inch of the media of the combination; but not to a noticeable extent in the remaining media. The increase in weight of the upstream and downstream filters due to dirt load was 0.35 and 0.05 pounds, respectively, for a total of 0.43 lb. reaching the filter.

After the filters had been removed from the test dust, the section of the duct five feet long downstream of the unit, and upstream of a 3/4 inch thick wood strip fastened flat across the bottom of the test duct, was carefully swept out with a fine brush. The amount of material obtained from the duct by this sweeping was 0.5 gram, or 0.26 percent of the dust load reaching the filter, constituting the fall-out in the first five feet of the duct

from the air passing through the filters, and consisting for the most part of large dust particles.

Cellophane tapes, stretched across the test duct downstream of the filter with the adhesive side facing upstream, indicated upon visual and microscopic examination after exposure to the air stream that some particles of sizes up to approximately 125 microns had passed through the filters during the dirt-loading tests. Particles much smaller than five microns were observed in quantity by microscopic examination of the downstream filter papers obtained in tests with aerosols A and C. No lint was observed on the tapes during these tests.

5. DISCUSSION OF RESULTS

In using throwaway air filters, the possibility exists of using, for example, two one-inch units in tandem in place of one two-inch unit. Since most of the dirt is arrested on the upstream media, renewal in the case of the tandem combination would consist of disposal of the loaded upstream one-inch filter, moving the downstream filter to the upstream position, and setting a new one-inch unit downstream of the other. Depending on performance, and the difference in cost of new two-inch and one-inch units, the tandem arrangement might have advantages.

The data in this report on a tandem arrangement for one-inch Glasfloss filters, and that in National Bureau of Standards Report No. 3814 on a two-inch Glasfloss filter, obtained under the same test conditions, allow a comparison of the two installations to be made. The pertinent performance data are summarized in the table below. Cost data are not included.

	<u>One Two-Inch</u>	<u>Two One-Inch</u>
Initial P.D. at 800 cfm	0.15	0.21
Dirt load at 0.5" P.D., grams	260	180
Avg. dust-spot efficiency, from initial P.D to 0.5"		
P.D., %	81.5	83

As indicated in this report, the downstream unit of the tandem arrangement gained only 0.05 lb in weight during the tests, as compared to 0.35 lb for the upstream filter.

It is concluded that practically speaking the downstream unit was, at the end of the test, as good as a new one, for use in the upstream position.

The average dust-spot efficiency was almost the same for both arrangements, but the tandem combination had only about 70% of the dirt-holding capacity, at a final pressure drop of 0.5 inch W.G., of the two-inch unit. This is believed to be due to the greater initial pressure drop of the tandem pair, resulting possibly from the doubling of the metal face retainers. An economic comparison of the merit of one arrangement over the other should take into account the more frequent changes of filters in the tandem arrangement, as well as the unit cost of the filters. It would appear that the one-inch unit would have to cost not more than 180/260, or 70%, as much as a two-inch unit to make the tandem arrangement as satisfactory as one two-inch unit, not counting the expense of making the more frequent changes.

TABLE 1

Pressure Drop of Clean Oiled Filter

<u>Air Flow</u>	<u>Face Velocity</u>	<u>Pressure Drop (1)</u>
cfm	fpm	inch W.G.
1200		0.395
1000		.302
800		.211
600		.140

(1) Initial values for the clean filter.

TABLE 2

Performance of Filter at 800 CFM

<u>Inlet Aerosol (1)</u>	<u>Total Dirt Load (2)</u>	<u>Pressure Drop</u>	<u>Eff. Meas. Technique (3)</u>	<u>Efficiency</u>
	grams	inch W.G.		percent
A	-	0.211	M	9
	-	.211	L	12
C	7	.222	N	76
	14	.228	N	79
	37	.259	N	82
	100	.349	N	84
	194	.523	N	87
A	194	.523	L	34

- (1) Aerosol A: Particulate matter in atmospheric air at NBS.
 Aerosol C: Cottrell precipitate in atmospheric air
 (1 gram per 1000 cf).

- (2) Average mixture: 4% lint, 96% Cottrell precipitate, by weight.

- (3) Efficiency measuring technique:

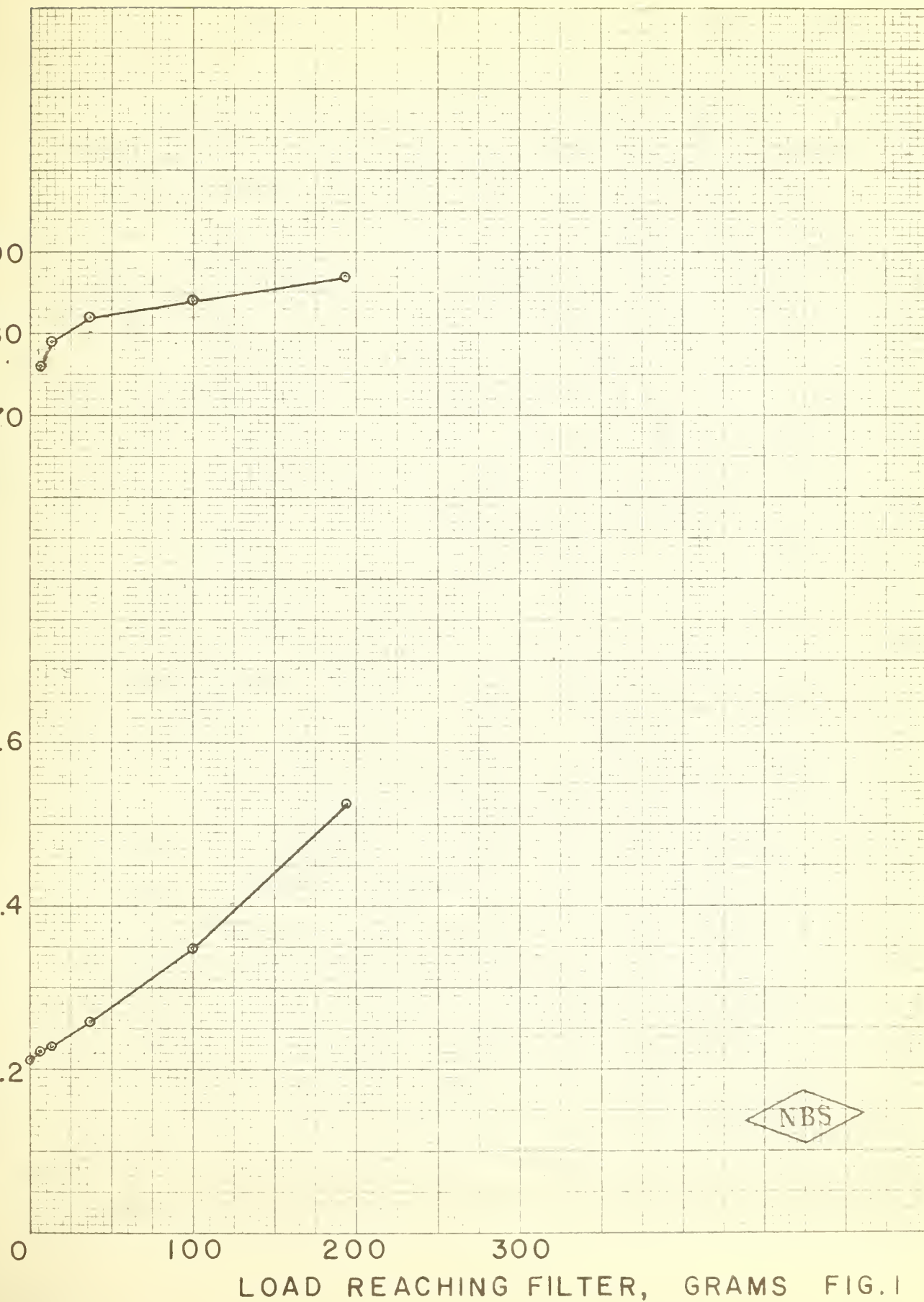
L: Air sampled at equal rates through equal areas; upstream sampling time selected to yield approximately equal dust-spot opacities both upstream and downstream.

M: Air sampled at equal rates through equal areas for equal times.

N: Air sampled at equal rates for equal times; downstream areas selected to obtain approximately equal dust-spot opacities both upstream and downstream.

EFFICIENCY, PERCENT

PRESSURE DROP, INCH W. G.



NBS

FIG.1

THE NATIONAL BUREAU OF STANDARDS

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The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to Government Agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. A major portion of the Bureau's work is performed for other Government Agencies, particularly the Department of Defense and the Atomic Energy Commission. The scope of activities is suggested by the listing of divisions and sections on the inside of the front cover.

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The results of the Bureau's work take the form of either actual equipment and devices or published papers and reports. Reports are issued to the sponsoring agency of a particular project or program. Published papers appear either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three monthly periodicals, available from the Government Printing Office: The Journal of Research, which presents complete papers reporting technical investigations; the Technical News Bulletin, which presents summary and preliminary reports on work in progress; and Basic Radio Propagation Predictions, which provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: The Applied Mathematics Series, Circulars, Handbooks, Building Materials and Structures Reports, and Miscellaneous Publications.

Information on the Bureau's publications can be found in NBS Circular 460, Publications of the National Bureau of Standards (\$1.25) and its Supplement (\$0.75), available from the Superintendent of Documents, Government Printing Office. Inquiries regarding the Bureau's reports and publications should be addressed to the Office of Scientific Publications, National Bureau of Standards, Washington 25, D. C.

